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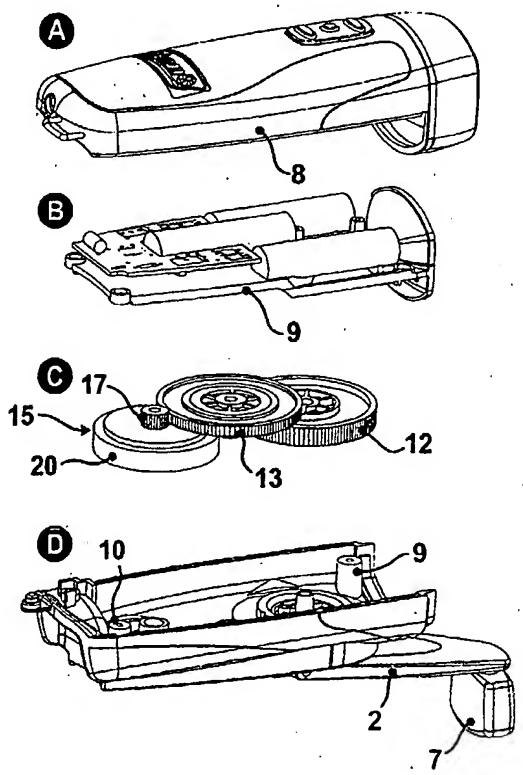
(54) Abstract Title
Manually Powered Flashlight with Control Circuitry

(57) A flashlight comprises a manual power generator, the generator comprising a main casting housing an input gear for driving an alternator via at least one intermediate gear so as to provide a step-up drive ratio; the gears and the alternator rotor all having their rotational axes perpendicular to the base of the main casing and in a single straight line; a rectifier circuit; a control circuit for modifying the rectifier output to a voltage/current appropriate to the device, and wherein the input gear is connected to a drive member rotatable by manual action through a folding crank arm, and wherein the flashlight further comprises a battery/batteries and a switch whereby the battery or the alternator can power the bulb, or the alternator charge the battery. The flashlight may also include a bright/dim selector switch, a socket for receiving external power to charge the battery, an indication means to show that sufficient power is being generated, or a stator in the alternator with skewed teeth.

Figure 3



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Figure 1

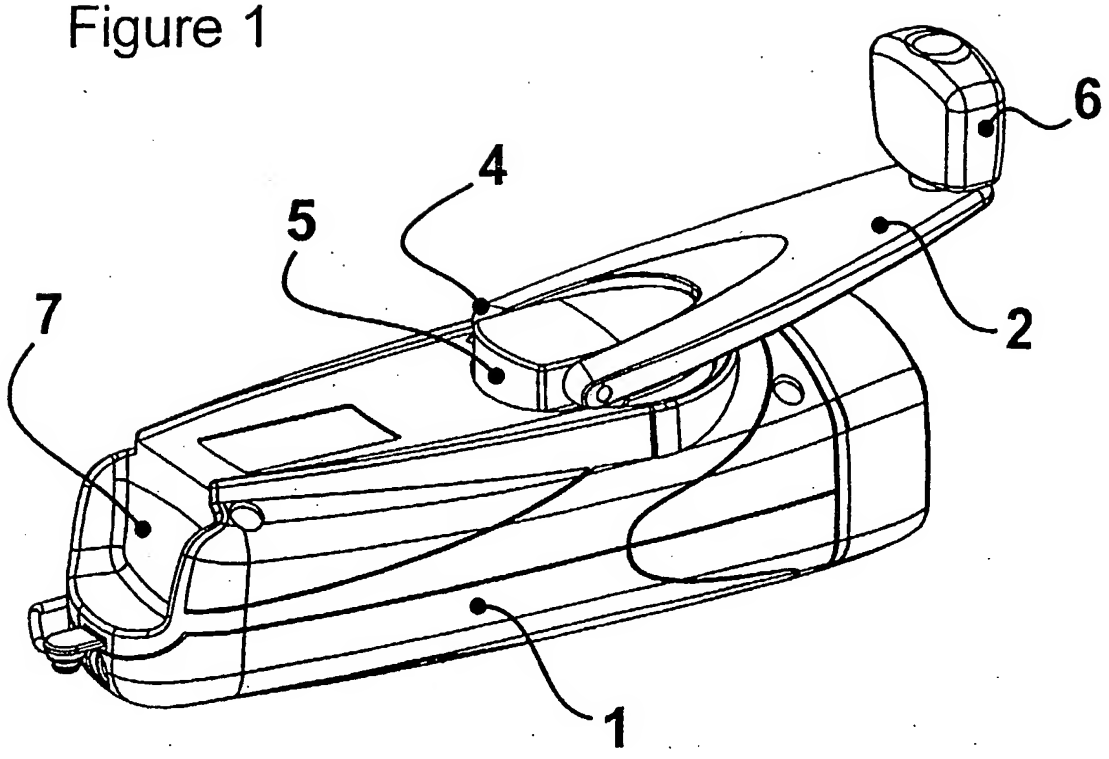


Figure 2

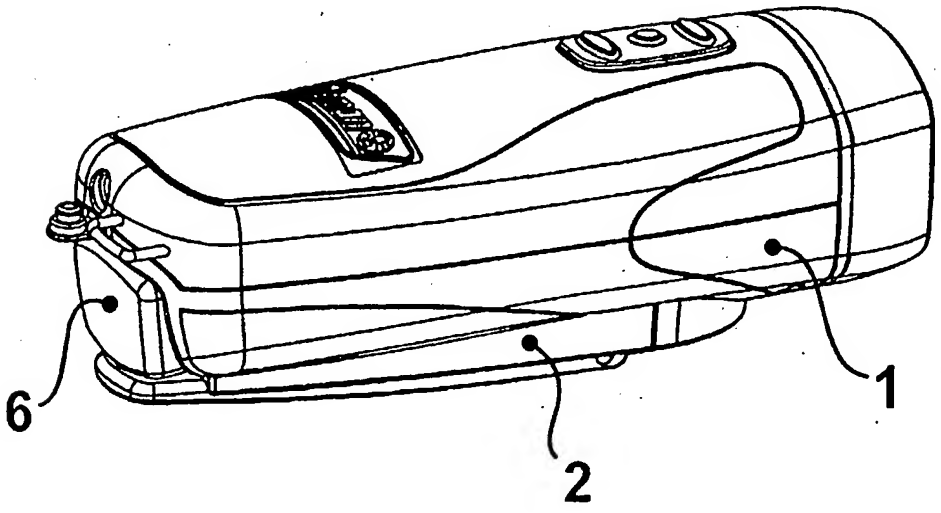


Figure 3

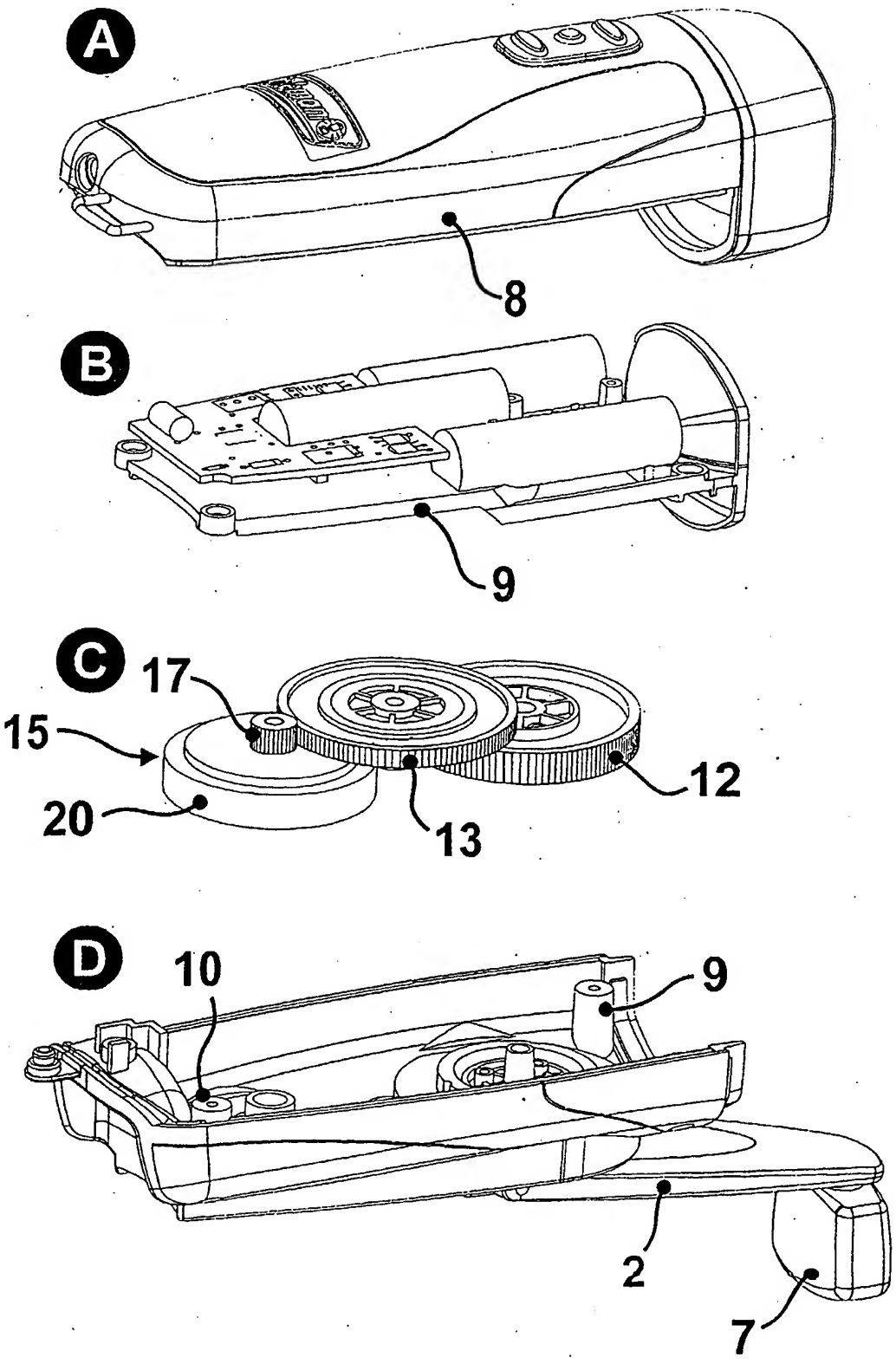


Figure 4

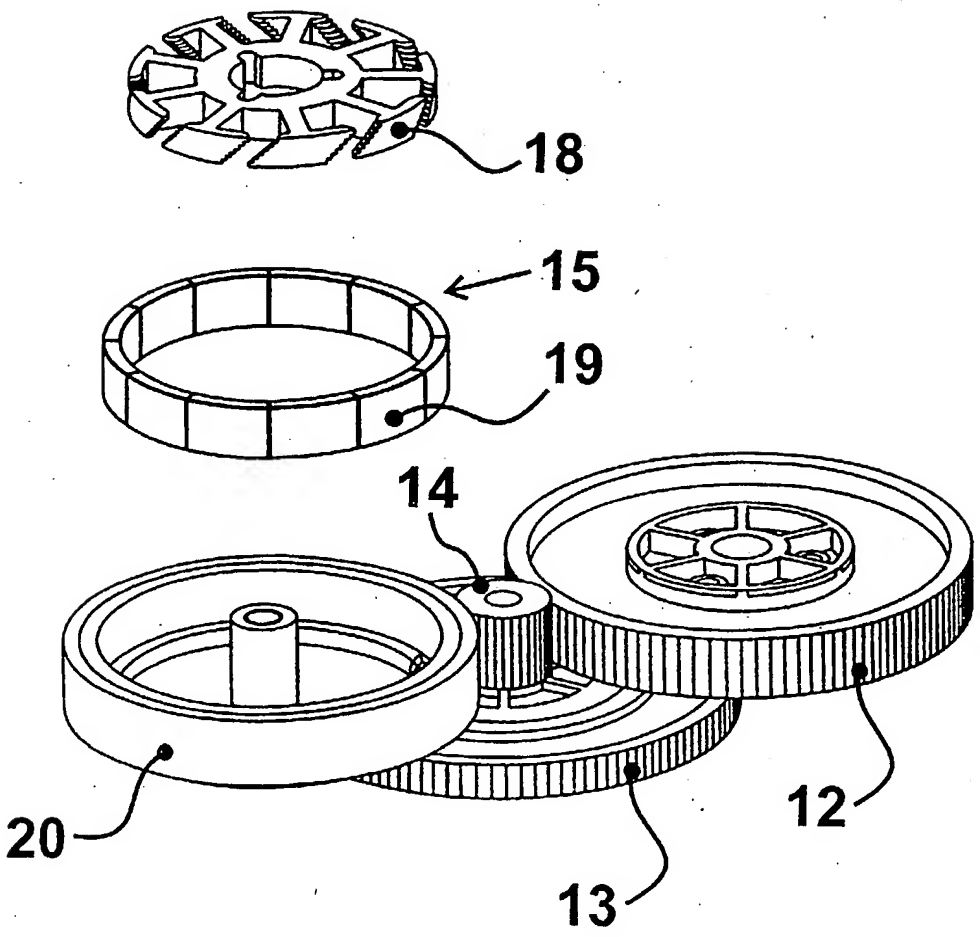
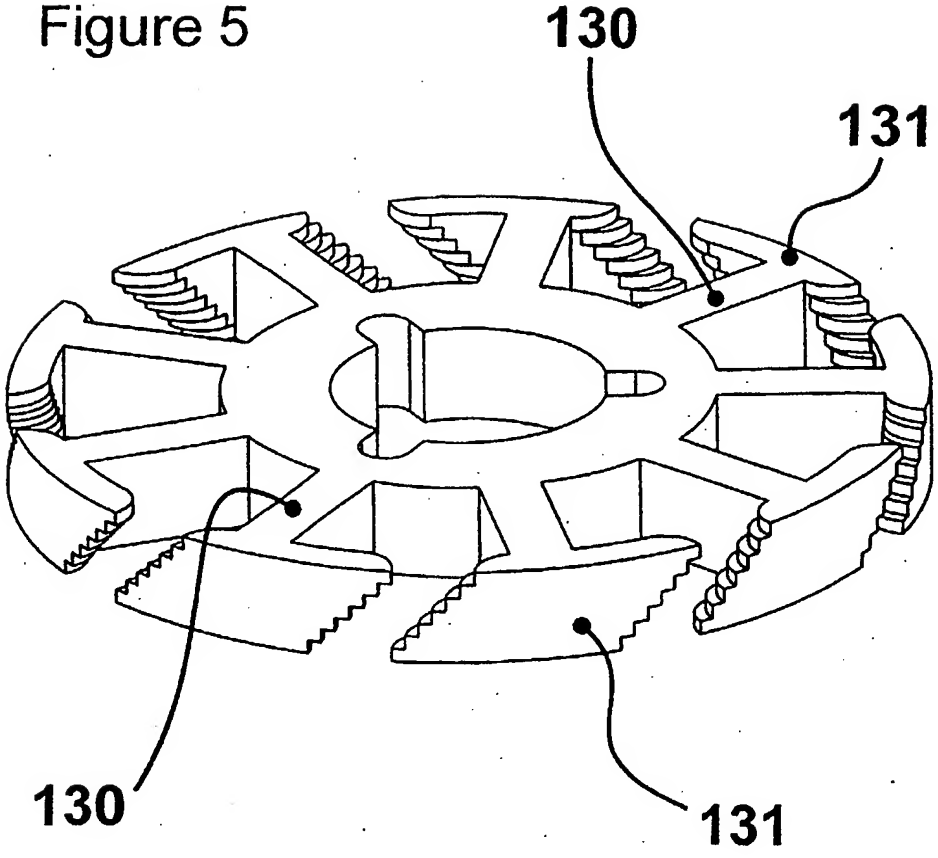


Figure 5



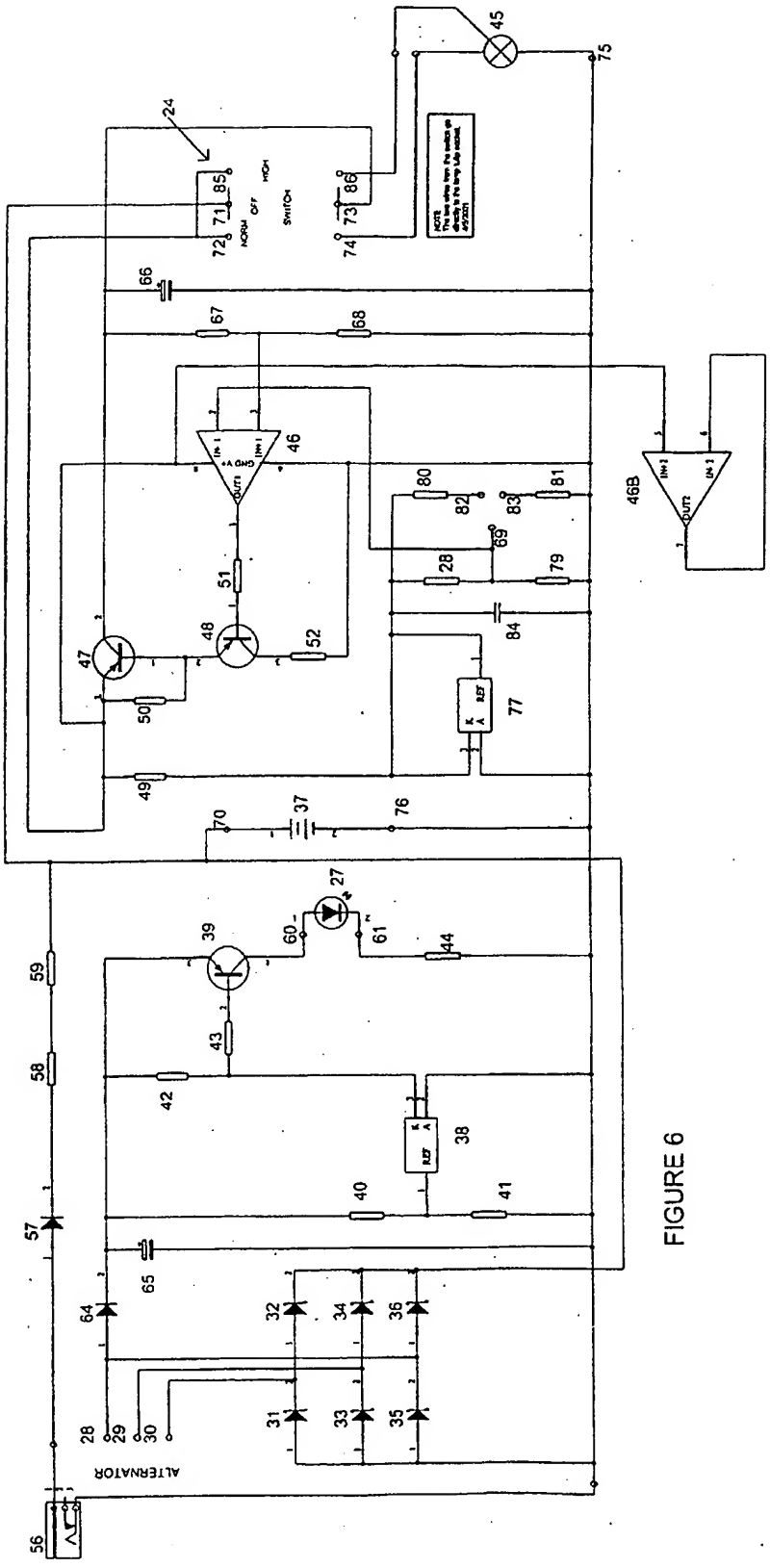


FIGURE 6

FLASHLIGHT

The present invention is concerned with flashlight in which the necessary electrical energy can be generated manually.

There have been many proposals for such flashlights. However, all of these prior art systems are relatively cumbersome and inefficient.

In accordance with a first aspect of the present invention there is provided a flashlight comprising a manual power generator for the bulb of the flashlight, the generator comprising a main casting housing an input gear for driving an alternator via at least one intermediate gear so as to provide a step-up drive ratio in the range of;

the input gear, the or each intermediate gear, and the rotor of the alternator all having their rotational axes perpendicular to the base of the main casing so that the gears and rotor rotate parallel to the plane of the base;

a rectifier circuit for rectifying the alternator output;

a control circuit for modifying the rectifier output to a voltage/current appropriate for the flashlight bulb,

and wherein the input gear is connected to a drive member rotatable by manual action to rotate the input gear in turn, the axes of the drive member being parallel to the respective axes of the input gear, the or each intermediate gear and the rotor with all the axes lying in a single straight line, one end of the drive member being pivotally connected to one end of a crank arm which is movable into an operation position from a stored position in which it lies parallel to the base of the casing which with its free end held in a recess in the other end of the casing, the longitudinal axis of the crank arm in its stored position lying orthogonally across the axes of rotation of the gears and the alternator, and wherein the flashlight further comprises a battery mounting in which a battery or batteries can be mounted so that when mounted the battery/batteries can power a bulb, and a switch means whereby the battery or the alternator can either power the bulb or the alternator charge the battery.

In order that the present invention may be more readily understood, embodiments thereof will now be described by way of example and with reference to the accompanying drawings.

In the accompanying drawings:

Figures 1 and 2 are perspective views of a flashlight in accordance with the invention;

Figures 3A, B, C and D are exploded perspective views of the accessory of Figures 1 and 2;

Figure 4 is an exploded perspective view of the alternator of the flashlight of Figures 1 and 2;

Figure 5 is a perspective view of a novel stator for use in the embodiment of the invention; and

Figure 6 is a diagram of a power control circuit used in the flashlight.

Turning now to Figure 1 of the accompanying drawings, this shows a torch having an external casing 1 carrying a folding crank arm 2. The crank arm 2 has a free end indicated at 3 and its other end is pivotally connected at 4 to a crank 5. As can be seen from Figure 2 the pivot 4 enables the crank arm to be pivoted through substantially 180° and has mounted on its free end a small rubberised handle 6. When the crank arm is stowed in its inoperative position the handle sits in a socket

7. The main casing 1 is configured so that it can easily be held in one hand by a user so that the crank mechanism can be operated by the user's other hand.

For ease of assembly the casing 1 is manufactured in two parts namely a top casing 8 and bottom casing 9. The two casing halves are connected by bolts (not shown) passing through cylindrical protrusions 10 and 11 which also act to locate the top casing with respect to the lower casing when they are assembled together.

The length of the crank arm is designed to optimise power input for a particular input speed and the crank 5 itself is mounted on a low friction bearing.

The crank arm 2 is connected directly to an input gear 12 which transfers the relatively low speed rotation from the crank mechanism to an intermediate gear 13. The input gear 12 has straight cut teeth for high efficiency and as it transfers high torque it also has wide tooth faces.

The intermediate gear 13 receives motion from the input gear via a small diameter gear wheel 14 and transfers motion from the input gear 12 to an alternator assembly generally indicated at 15 via a large diameter gear 16

which meshes with a small diameter gear 17 of the alternator assembly. Thus the intermediate gear 13 transfers motion from the input gear 12 to the alternator assembly and at the same time increases the relatively low speed input from the input gear 12 to a high speed output suitable for the alternator. A suitable gearing ratio for this transference is for one rotation of the input gear 12 causes between 20 and 60 rotations of the alternator assembly 15. The choice of the gear ratio is a matter of some importance. The ideal is to have a relative low manual input rpm with high efficiency output from the alternator. A typical input (crank) rpm which can be easily achieved by a user is between 100 and 140rpm. If high power is requested from a small package then a higher gear ratio would be needed. However this can cause problems because of a high initial torque requirement. In the present embodiment the ratio is 30. The various gears and alternator are housed in casing half 11.

The alternator is shown in exploded form in Figure 4 and comprises an alternator stator 18 carrying copper windings which are not shown and an alternator rotor 20 in which are mounted magnet segments 19 which provide the rotor poles. The alternator uses a three phase stator winding with nine stator teeth and twelve rotor poles

making in total six pole pairs. It is of course possible that more than three phases may be used. The alternator rotor 20 is in the form of a flattened cup with a boss. The gear is mounted on this boss.

The magnets 19 used in the alternator are a high grade of neodium-iron-boron (NFeB, or NiB) sintered rare earth magnets. The alternator has a relatively high initial cogging torque, which is multiplied backwards by the transmission ratio, so that an unacceptably high starting torque can result. In order to reduce the effect of this cogging torque both the magnetic pole edges as well as the stator pack in this embodiment are skewed about the alternator axis. It can be seen from Figure 4 that the laminations are identical and that each lamination is angularly skewed with respect to its neighbouring laminations in order to achieve the necessary skewed effect. This also has the secondary effect of smoothing the torque input and giving quiet operation even during high power generation. The alternator rotor 20 is mounted in a sintered brass bush impregnated with very low friction lubricant.

The stator pack 18 is made up of a number of laminations of thin steel so as to reduce eddy currents and their associated losses. Because of this high field strength

it is essential to ensure the accurate location of the alternator rotor. Thus the alternator rotor 20 is located axially only by the magnetic field associated with the magnetic circuit formed by the alternator stator, alternator rotor and the magnet segments. Thus it is not fixed with regard to movement along the axis of its rotation. This ensures that there is no axial bearing loss and locates the alternator rotor automatically in the optimum position for maximum flux density in the stator teeth. The stator axial locating face is machined with the rotor bearing housing in the same operation in order to ensure that the stator and the rotor are properly aligned to avoid out of plane magnetic forces which would increase friction bearing and reduce flux density.

Referring now to Figure 5 it will be appreciated that a discussion has already been given with regard to the importance of reducing the cogging effect when the generator is initially started. In order to reduce the cogging effect both the stator laminations and the permanent magnets were skewed. It has also been found that given the performance of the stator 18 can be improved by not using identical laminations each of which is angularly displaced with respect to its neighbour. In the stator shown in Figure 5 each stator is provided

with stator arms 130 which are identical. However the requisite skewing effect of the stator teeth is provided by varying each lamination and specifically by farying the teeth of the laminations. It will be seen that each tooth 131 extends on either side of its stator arm with the input hand extension of the uppermost tooth being substantially longer than the left hand extension. The skewed effect is obtained by progressively reducing the right hand lengths and progressively increasing the left hand lengths. This arrangement enables the copper windings around the arms of the stator to be more effective as the cross-sections of the arms are not skewed so that it is no longer necessary to skew the alternator rotor magnets.

As can be seen from Figure 3 the two casing halves 8 and 9 are bolted together on either side of a central, substantially planar, unit 21. This unit 21 carries a circuit board 22 and also has mounting 23 for one or more batteries which are preferably of the lithium ion or lithium polymer type. The upper casing half 8 carries a switch 24 by means of which a user can turn the flashlight on and select either high or low output filaments from a two-filament bulb (not shown) mounted in a standard reflective casing 25. The flashlight also has a socket 26 from which the battery/batteries can be

charged from an external power supply and a light, preferably an LED 27, the purpose of which will be described hereinafter.

The operation of the circuitry of the circuit board 22 will now be described in relation to Figure 6 of the accompanying drawings.

The three-phase output of the alternator 15 is connected via pads 28, 29, 30 to a rectifier module consisting of diodes 31, 32, 33, 34, 35 and 36 so as to charge a battery 37.

An "effort indicator" circuit comprises a programmable reference device 38 and a transistor 39 with associated resistors 40, 41, 42, 43 and 44 which monitors the alternator output and lights up the LED 27 when there is meaningful output from the alternator.

The output of the alternator can also be used to drive the filaments of the two-filament bulb indicated at 45 and a low drop out regulator circuit is used to limit the voltage which can be supplied to the bulb 45 from the alternator to 3.3. volts. Naturally other voltages might be used for different types of bulbs.

The low drop out regulator circuit comprises a comparator

46 and a pair of transistors 47, 48. The reference voltage used by comparator 46 can be trimmed using resistors 80 and 81 to take component tolerances into account.

Power to the bulb 45 is controlled by the switch 24 which is a three-position switch shown in the "OFF" state. One pair of terminals connect to the high power filament of the bulb 45 when bright light is required and the other pair connects power to the low power filament when power conservation is required.

In this embodiment the battery 37 can be charged from an external source via a socket 56, via a diode 57 and resistors 58 and 59.

The diode 57 is used for polarity protection and the resistors 58 and 59 to set the charging current drawn from the external adaptor. Resistors 58 and 59 also limit the charging current if the bulb is on and the battery is flat.

When the battery 37 is being charged by the alternator current flows via diodes 32, 34 and 36 and contact pad 70 to the battery 37 and then back via a contact pad 76 and a resistor 63 to diodes 31, 33 and 35.

As mentioned the circuit includes an effort indicator to show a user that the alternator is providing a meaningful output. In the effort indicator circuit power from the alternator is taken via pad 28 and a half-wave rectifier diode 64. This power is smoothed by a capacitor 65.

The programmable reference circuit 38 will try to divert the current from diode 64, resistor 42, and its terminal to ground when the voltage across capacitor 65 exceeds a preset voltage. This preset voltage is set by the ratio between resistors 40 and 41, the junction of which is connected to the reference input of reference device 38. Current will also be diverted via the emitter and base of transistor 39, resistor 43 to reference circuit 38. Thus transistor 39 will switch on so that current flows from the emitter of transistor 39, its collector, pad 60, LED 27, pad 61 and resistor 44 to ground so that the LED 27 will illuminate to show optimum input. The final main circuit is the main regulator circuit for the bulb. This circuit includes operational amplifier 46 which compares the voltage of the output across capacitor 66 via resistors 67 and 68 with a reference voltage at pad 69. The output of the operational amplifier 46 drives transistor 47 via transistor 48 so that the output voltage is kept constant.

When the torch is switched on then current flows from battery 37, positive pad 70, pad 71, switch 24, pad 72 through the emitter and collector of transistor 47, pad 73, pad 74, bulb 45, pad 75, and pad 76 to the negative terminal of the battery 37.

Current also flows via resistor 49 and programmable precision reference circuit 77 to ground to provide a reference voltage at pins 1 and 3 of the precision reference circuit 77. This voltage is divided in half by resistors 28 and 79 and this voltage is applied via pad 69 to the minus input of operational amplifier 46. To allow for tolerances in the reference voltage, a facility is provided to adjust the voltage slightly up or down by means of strapping pad 69 to either resistor 80 or resistor 81 via respective pads 82,83. Stability for the precision reference circuit 77 is provided by means of capacitor 84.

If the output across capacitor 66 is lower than desired then the voltage at the junction of resistors 67 and 68 will also be lower. Thus the voltage at the plus input of the operational amplifier 46 will be lower than that at its minus input. The output voltage of the operational amplifier 46 will therefore decrease. Current flow will increase from emitter and base of

transistor 47, emitter and base of transistor 48 to the output of the operational amplifier 46.

Current flow will consequently increase from the emitter and base of transistor 47, emitter and collector of transistor 48 via resistor 52 to ground. This increase in current through emitter and base of transistor 47 will therefore turn it on to a greater degree. The voltage across capacitor 66 will increase until the voltage on both inputs of the operational amplifier 46 are the same.

If the output across capacitor 66 is higher than desired, then the voltage at the junction of resistors 67 and 68 will also be higher. Thus the voltage at the plus input of the operational amplifier 46 will be higher than that at its minus input. The output voltage of the operational amplifier 46 will therefore increase. Current flow will therefore decrease from the emitter and base of transistor 47, emitter and base of transistor 48 and resistor 51 to the output of the operational amplifier 46. Current flow will consequently decrease from the emitter and base of transistor 47, emitter and collector of transistor 48 and resistor 52 to ground. This decrease in current through the emitter and base of transistor 47 will therefore turn it on to a lesser degree. The voltage across capacitor 66 will decrease

until the voltage on both inputs of the operational amplifier 46 are the same. Resistor 50 is present in order to switch transistor 47 off if the output of operational amplifier 46 is high.

From the above it will be appreciated that switch 24 can connect the battery from the regulator circuit and selects either normal and high filaments of the lamp in accordance with whether pads 71/72 and 73/74 are contacted or pads 71/85 and 73/86.

From the above description it will be seen that a simple circuit is provided which enables a carefully regulated voltage to be supplied to the bulb either from the alternator if the battery is flat or from the battery. Additionally the battery can be charged from the alternator input or from an external power supply. The resulting flashlight is both compact, easy to handle and highly efficient.

CLAIMS:

1. A flashlight for generating electrical power comprising a manual power generator for the bulb of the flashlight, the generator comprising a main casting housing an input gear for driving an alternator via at least one intermediate gear so as to provide a step-up drive ratio;

the input gear, the or each intermediate gear, and the rotor of the alternator all having their rotational axes perpendicular to the base of the main casing so that the gears and rotor rotate parallel to the plane of the base;

a rectifier circuit for rectifying the alternator output;

a control circuit for modifying the rectifier output to a voltage/current appropriate for the consumer device, and wherein the input gear is connected to a drive member rotatable by manual action to rotate the input gear in turn, the axes of the drive member being parallel to the respective axes of the input gear, the or each intermediate gear and the rotor with all the axes lying in a single straight line, one end of the drive member being pivotally connected to one end of a crank arm which is movable into an operation position from a stored position in which it lies parallel to the base of the

casing which with its free end held in a recess in the other end of the casing, the longitudinal axis of the crank arm in its stored position lying orthogonally across the axes of rotation of the gears and the alternator, and wherein the flashlight further comprises a battery mounting in which a battery or batteries can be mounted so that when mounted the battery/batteries can power a bulb, a switch means whereby the battery or the alternator can either power the bulb or the alternator charge the battery.

2. A flashlight according to claim 1 comprising switch means for switching power to the bulb mounting so that a mounted bulb can operate in either a bright, high power consumption mode or a less bright, less power mode.

3. A flashlight according to claim 1 or claim 2 including a socket for receiving external power to charge said battery/batteries.

4. A flashlight according to any preceding claim including means for indicating to a user that the alternator is generating sufficient power.

5. A flashlight according to any preceding claim and including a regulator circuit for regulating power

supplied to a mounted bulb.

6. A flashlight according to any preceding claim wherein the flashlight has an outer casing of plastics material bolted around a substantially planar support carrying a circuit board for controlling the output of the regulator.

7. A flashlight according to any one of the preceding claims wherein the generator comprises an alternator rotor housing an array of magnets and rotatable with respect to a stator, the stator being formed from a plurality of laminations.

8. A flashlight according to claim 7 wherein the stator teeth are skewed with respect to the rotation axis of the alternator so as to reduce cogging effects.

9. A flashlight according to claim 8, wherein the stator laminations each have a plurality of identical stator arms which are aligned with each other, the arms of each stator lamination carrying a tooth portion transverse to the arm, the tooth portion of each stator lamination being different from to the tooth portions of the other stator laminations so that the teeth of the stator formed by the tooth portions are skewed but the

stator arms are not.

10. A flashlight according to any of claims 7, 8 or 9, wherein the alternator rotor is axially located only by the magnetic field associated with the magnetic circuit formed by the stator and the alternator magnets.

INVESTOR IN PEOPLE

Application No: GB 0123745.2
Claims searched: 1-10

Examiner: Peter Keefe
Date of search: 4 February 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F4R RFR

Int Cl (Ed.7): F21L, H02K

Other: Online: WPI, PAJ, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB2353854 A	FREEPLAY p10 lines 3-8, 20-22; claims 5-7	
A	GB2332268 A	FREEPLAY p3 lines 2, 15, 16; p5 lines 5-9; p7 line 23-p8 line 2; line 13-p9 line 7; p10 lines 17-21	
A	US4701835 A	THE UNITED STATES col. 2 lines 15-24, 33-44; col. 3 line 11; col. 5 lines 56, 57	
A	US4360860 A	JOHNSON col. 2 lines 6-11; col. 5 lines 26, 27; col. 9 lines 58-66; col. 13 lines 63-66	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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